

Remarks:

Reconsideration of the application is requested.

Claims 1-24 and 27-28 remain in the application. Claims 1-2, 20 and 27 have been amended. Claims 24 and 28 have been withdrawn from consideration. Claims 25-26 have been cancelled.

In item 1 on page 2 of the above-identified Office action, claims 1 and 17 have been objected to because of informalities. Appropriate correction has been made.

In item 2 on page 2 of the above-identified Office action, claims 2 and 20 have been rejected as being indefinite under 35 U.S.C. § 112, second paragraph.

More specifically, the Examiner has stated that it is unclear from the expression "a diffusion barrier ... disposed at at least one of a surface of said contact holes and said connection pieces" in claim 2 whether the first or second contact holes is implied by the "contact holes". Appropriate correction has been made.

The Examiner has also stated that it is unclear from the expression "said further diffusion blocker prevents bulk outdiffusion of copper into said insulation layer" in claim 20 whether the first or second insulation layer is implied by the "insulation layer". Appropriate correction has been made.

It is accordingly believed that the claims meet the requirements of 35 U.S.C. § 112, second paragraph. Should the Examiner find any further objectionable items, counsel would appreciate a telephone call during which the matter may be resolved. The above-noted changes to the claims are provided solely for cosmetic and/or clarificatory reasons. The changes are neither provided for overcoming the prior art nor do they narrow the scope of the claims for any reason related to the statutory requirements for a patent.

In the second paragraph on page 3 of the above-mentioned Office action, claims 1-7, 18-23 and 27 have been rejected as being unpatentable over Cheek et al. (US Pat. No. 5,935,766) in view of Cohen et al. (US Pat. No. 5,679,269) and further in view of Bothra et al. (US Pat. No. 5,798,559) under 35 U.S.C. § 103(a).

As will be explained below, it is believed that the claims were patentable over the cited art in their original form and

the claims have, therefore, not been amended to overcome the references.

Before discussing the prior art in detail, it is believed that a brief review of the invention as claimed, would be helpful.

Claim 1 calls for, inter alia:

at least one diffusion blocker disposed underneath said electrical connecting leads, said diffusion blocker at least one of impeding and preventing a diffusion of copper, said diffusion blocker configured as a blocker layer interrupted only in a region having said first contact holes formed therein, said blocker layer disposed between said first insulation layer and said second insulation layer. (Emphasis added.)

Cheek et al. show first and second insulating layers 130, 160 having respective contact holes. The first contact hole 140 within the first insulating layer 130 is filled with metal. The first contact hole 140 is covered with an aluminum metal line 150. The second contact hole 190 above the metal line 150 is filled with tungsten. The Examiner has already admitted that Cheek et al. do not teach that the contact holes 190 are filled with copper in a whole-area manner and do not teach that a diffusion blocker layer is formed between the first and second insulating layers 130, 160 underneath the electrical connecting leads 150 (see the first paragraph on page 4 of the Office action).

However, the Examiner has stated that filling a contact hole in a whole-area manner is known from Cohen et al. As far as the diffusion blocker layer is concerned, the Examiner refers to Bothra et al.

It is true that Bothra et al. disclose a layer 116 which can be a silicon nitride layer. However, the purpose of layer 116 is different from the diffusion blocker layer (160) of the invention of the instant application. A person skilled in the art would not be motivated by the disclosure of Bothra et al. to include such a layer in the structure of Cheek et al., namely between the first and second insulation layers 130, 160 underneath the metal line 150.

The semiconductor structure according to claim 1 of the instant application is optimized to prevent copper in the second contact hole (330) from diffusing downwardly to the semiconductor substrate. The blocking function is achieved by the combination of two measures. First, aluminum connection leads (250) are disposed above the first contact holes (170) (see page 17, line 8 of the specification). Second, a diffusion blocker layer (160) is disposed between the first and second insulating layers (150, 320). The diffusion blocker layer (160) is only interrupted in a region having the first contact holes formed therein.

In Bothra et al., the layer 116 may include silicon nitride, which material is one of the preferred ones for the diffusion blocker layer 160 of the invention of the instant application. However, the function of the layer 116 in Bothra et al. is different from the function of the layer (160) in the invention of the instant application. The objective of Bothra et al. is to provide an air dielectric formation 180, which means that dielectric layers 120 and 140 are sacrificial oxide layers and will be removed from the semiconductor structure through an isotropic etch process. It can be clearly seen from the etch step depicted in Fig. 4 that the function of layer 116 is to prevent the isotropic etchant 162 from attacking all structures beneath the layer 116. Especially, silicon substrate 100 is protected from moisture that may cause corrosion or contamination (see column 4, lines 54 to 57 of Bothra et al.).

A person skilled in the art who seeks to improve the structure known from Cheek et al. looks for something to prevent contamination of copper into a semiconductor substrate. Bothra et al. do not suggest a mechanism for the prevention of copper diffusion. Rather, Bothra et al. show a silicon nitride layer which is suitable to serve as an etch stop to prevent contamination and corrosion with moisture and the isotropic etchants. Bothra et al. do not mention that the layer 116 serves as a diffusion blocker to prevent copper from

contaminating silicon substrate. A person skilled in the art has no intention to remove oxide 160 from the structure of Cheek. Consequently, a person skilled in the art would not consider Bothra et al. as a relevant document.

There are further indicia which support the position that the layer 116 has not been a point of consideration in the question of diffusion-blocking of copper in Bothra et al. For example, the contact hole filling 134, which is comparable to the contact hole filling (330) of the invention of the instant application, does not contain any copper. The contact hole filling 134 of Bothra et al. is formed of Tungsten (see column 7, line 20). The problem of preventing metal diffusion caused by a metal plug is solved by diffusion barrier layer 112 and 108. The layers 112 and 108, however, are situated within the contact holes 114, 110 within the first insulating layer 106. Diffusion layers 112, 108 are not disposed on the first insulating layer.

In summary, a person skilled in the art who attempts to prevent contamination of silicon substrate from copper may learn from Bothra et al. to place a diffusion layer, e.g. 112, 108, within each contact hole, and will learn that a silicon nitride layer 116 disposed on insulating layer 106 may be useful as an etch stop for removing sacrificial oxide in order to obtain air insulation. However, a person skilled in the

art would not learn that the layer would serve as a diffusion blocker layer for above-disposed copper fillings of contact holes.

Consequently, Bothre et al. do not provide any hint toward placement of a diffusion blocker layer (160) within the structure of the invention of the instant application.

Cohen et al. disclose a layer 47 which may be formed of silicon nitride and covers an insulating layer 46. However, Cohen et al. do not use connection leads made of aluminum disposed above the diffusion blocker layer. Further, the barrier layer 47 is interrupted by the copper via 45 disposed above the layer 47. In contrast, in the invention of the instant application, the diffusion blocker layer (160) is interrupted by the first contact hole (170) which is below the diffusion blocker layer (160) and which would be comparable to contact 40 in Cohen et al. Cohen et al. solve the problem of copper diffusion by using diamond-like carbon material 46.

It is accordingly believed to be clear that none of the references, whether taken alone or in any combination, either show or suggest the features of claim 1. Claim 1 is, therefore, believed to be patentable over the art and since claims 2-7, 18-23 and 27 are ultimately dependent on claim 1, they are believed to be patentable as well.

In the last paragraph on page 6 of the above-mentioned Office action, claims 8-9 and 14-16 have been rejected as being unpatentable over Cheek et al. in view of Cohen et al., Bothra et al. and further in view of Chiang et al. (US Pat. No. 5,739,579) under 35 U.S.C. § 103(a).

As discussed above, claim 1 is believed to be patentable over the art. Since claims 8-9 and 14-16 are ultimately dependent on claim 1, they are believed to be patentable as well.

In the fourth paragraph on page 8 of the above-mentioned Office action, claims 12-13 have been rejected as being unpatentable over Cheek et al. in view of Cohen et al., Bothra et al. and further in view of Hong (US Pat. No. 6,008,117) under 35 U.S.C. § 103(a).

As discussed above, claim 1 is believed to be patentable over the art. Since claims 12-13 are ultimately dependent on claim 1, they are believed to be patentable as well.

In the second paragraph on page 9 of the above-mentioned Office action, claims 10-11 have been rejected as being unpatentable over Cheek et al. in view of Cohen et al., Bothra et al. and further in view of McCollum et al. (US Pat. No. 5,552,627) under 35 U.S.C. § 103(a).

As discussed above, claim 1 is believed to be patentable over the art. Since claims 10-11 are ultimately dependent on claim 1, they are believed to be patentable as well.

In view of the foregoing, reconsideration and allowance of claims 1-23 and 27 are solicited.

In the event the Examiner should still find any of the claims to be unpatentable, counsel would appreciate a telephone call so that, if possible, patentable language can be worked out.

If an extension of time for this paper is required, petition for extension is herewith made. Please charge any fees which might be due with respect to Sections 1.16 and 1.17 to the Deposit Account of Lerner and Greenberg, P.A., No. 12-1099.

Respectfully submitted,



For Applicants

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June 19, 2003

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